Plans and Proposals for Putting Gold Ions into the J10 Dump in AGS

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Reference:

L.A. Ahrens, "AGS Au77+ Beam Dumping (making holes in the vacuum chambers)", RHIC Retreat 2008.

"Conclusions and Open Ends" from Ahrens' Retreat Presentation:

1. We propose returning to dumping gold beam in AGS on the J10 Dump late in the AGS magnetic cycle (rather than extracting and transporting the beam to the W dump).

2. Figure of merit for dumping is the loss ratio J18/J12 (lower is better). This ratio was reduced significantly (from 10 or so down to 0.14) during Run 8 by re-positioning the dump and strengthing the dump bump.

3. We need less aperture in AGS for RHIC beams than we needed for high-intensity proton beams (for which the dump was built). We will therefore move the dump closer to the circulating beam. This requires some work in the ring.

4. We should make the dump bump power supply perform well enough to not be a concern, and build mechanisms to assure that we do not leave it off. Alarm if off? Put in beam permit system?

5. We added loss monitor logging and alarming during Run 8. We should improve the procedure to automatically set the alarm levels (for different gain settings) so this alarming will always be a positive addition for operations.

6. The new fast ring pressure monitoring allows alarming on pressure bumps which may be a useful strategy espesially at low energy.
7. Gold stripping (Au77+ to Au79+) during dumping remains under study.

The focus of the current presentation is our proposal to put gold beam into the dump by stripping to Au79+ in the J7 straight.

Here is what we propose:

1. Remove the skew sextupole in the J7 straight. To what extent (if any) do we rely on the 4 skew sextupoles in AGS?
2. Move the horizontal jump target mechanism from the F5 straight to the J7 straight. Can it be made to fit there?
3. Use the jump target mechanism to plunge a stripper into the circulating gold beam. The stripper would be the same material (tungsten) and thickness as the stripper in the ATR line. Will the beam "eat away" the edge of the stripper over time?
4. We would need to plunge the stripper from the <u>inside side</u> of the beam pipe. Does this present any problems at J7?
5. The dump bump would be adjusted so that the stripped Au79+ beam hits the upstream face of the dump. This would happen on the flattop of the AGS magnetic cycle.
6. After the plunge, the dump bump amplitude would be increased to put any unstripped beam into the dump. This offers protection from scenarios where the plunging mechanism fails or where the plunging is not set up properly.

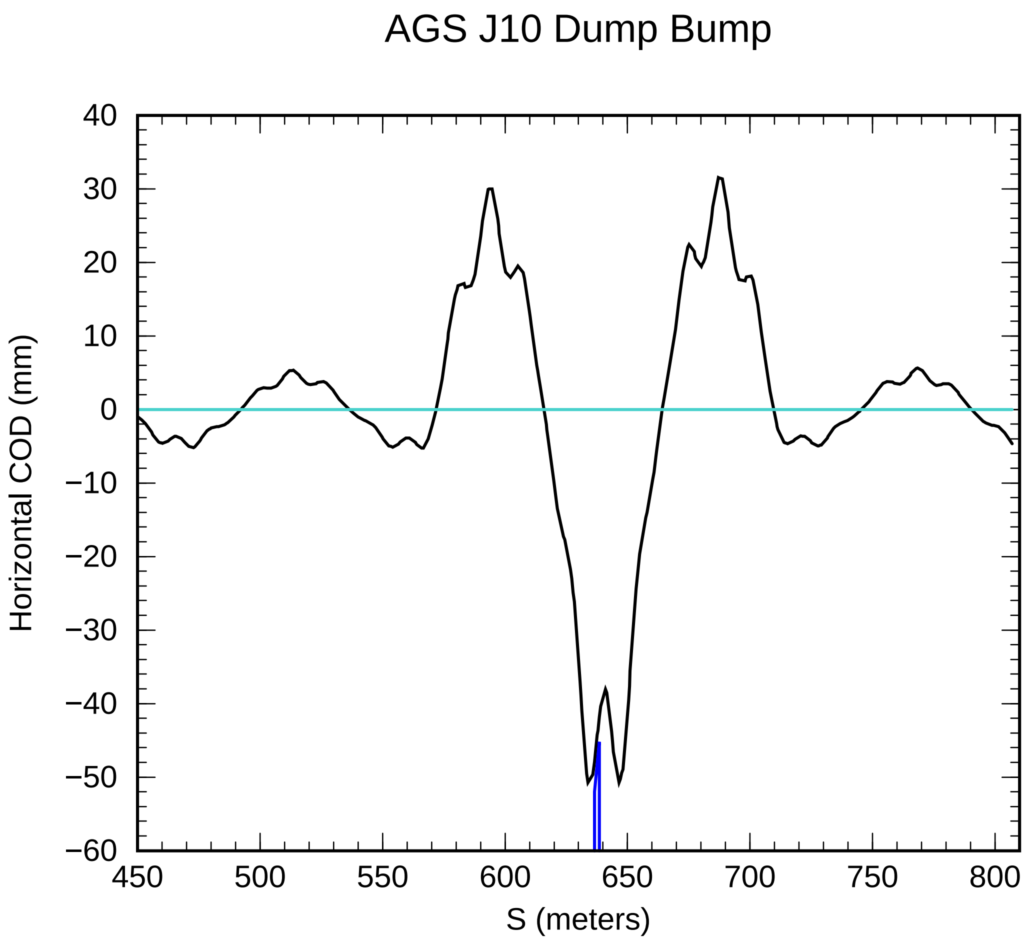

Figure 1: The black curve is the J10 dump bump. This is a standard AGS three-halves lambda bump obtained by exciting the backleg windings on four pairs of main dipole magnets. (In this case the I10, I11, J4, J5, J18, J19, K12, and K13 magnets.) Outside the bump region there is a residual orbit distortion that depends on the horizontal tune. The Blue lines show the outline of the J10 dump.

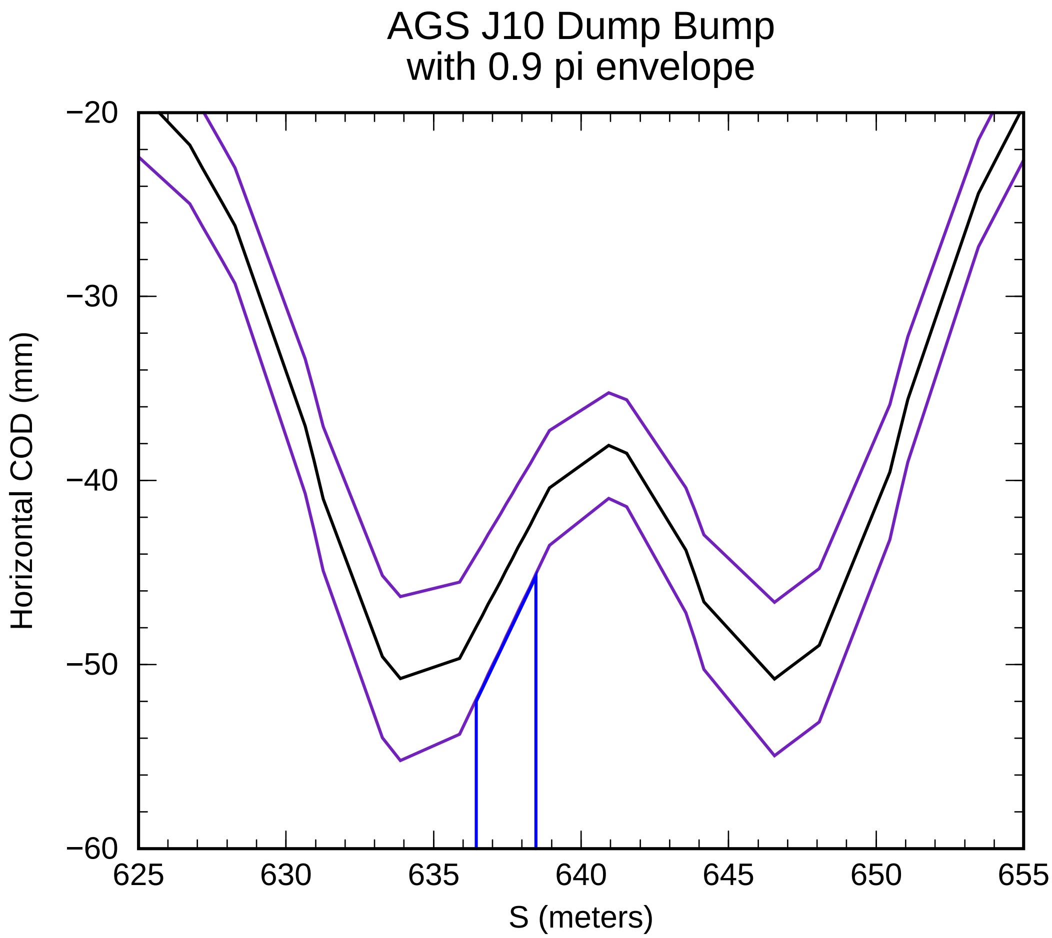

Figure 2: This is a "zoomed in" view of the previous figure. Here again the black curve is the J10 dump bump and the blue lines show the outline of the dump. The violet curves show the envelope of a 0.9π emittance beam. This is the actual size of gold beam in AGS at extraction assuming a normalized emittance of 10π. Beam is put into the dump by increasing the amplitude of the bump. The downstream end of the dump may be moved further to the inside (more negative) than shown to ensure that beam hits the upstream end. The circulating beam direction here is from left to right.

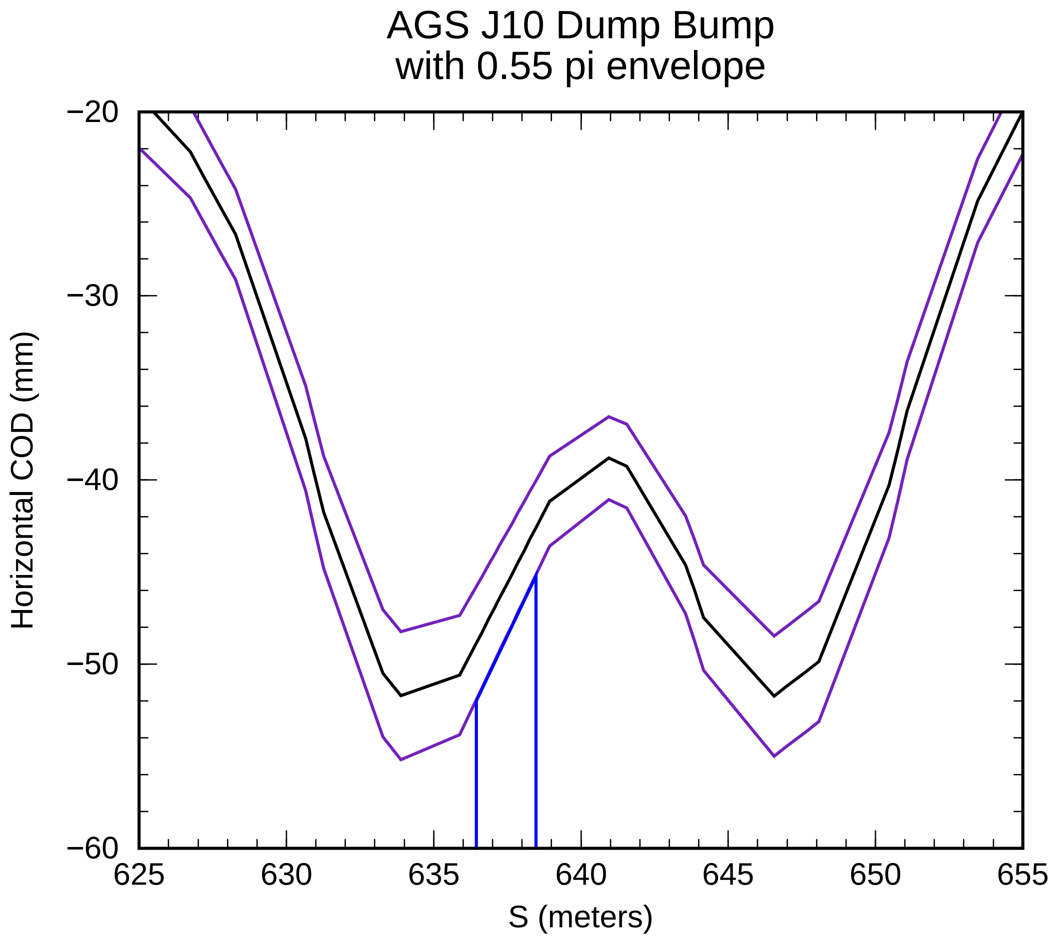

Figure 3: Here the bump amplitude has been inreased causing beam loss on the dump and reducing the beam emittance to 0.55π.

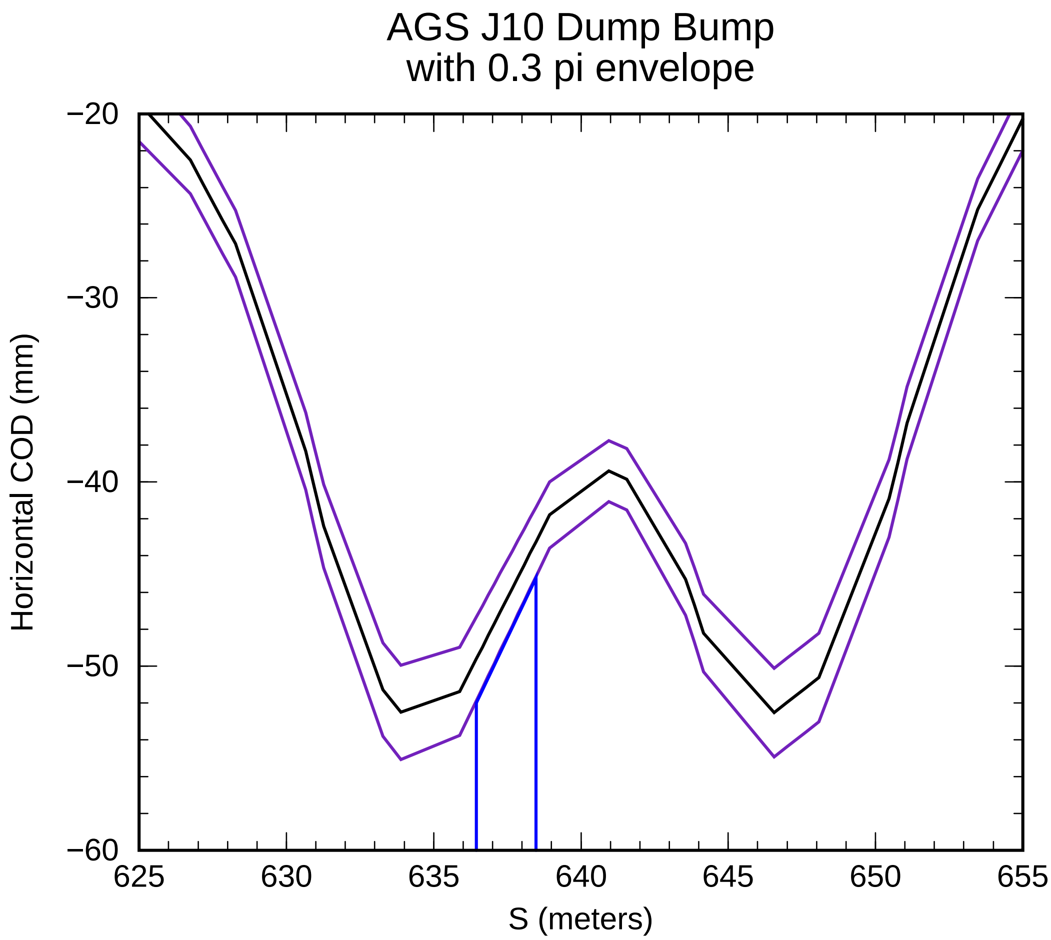

Figure 4: Here the bump amplitude has been inreased further, again causing beam loss on the dump and reducing the beam emittance to 0.3π.

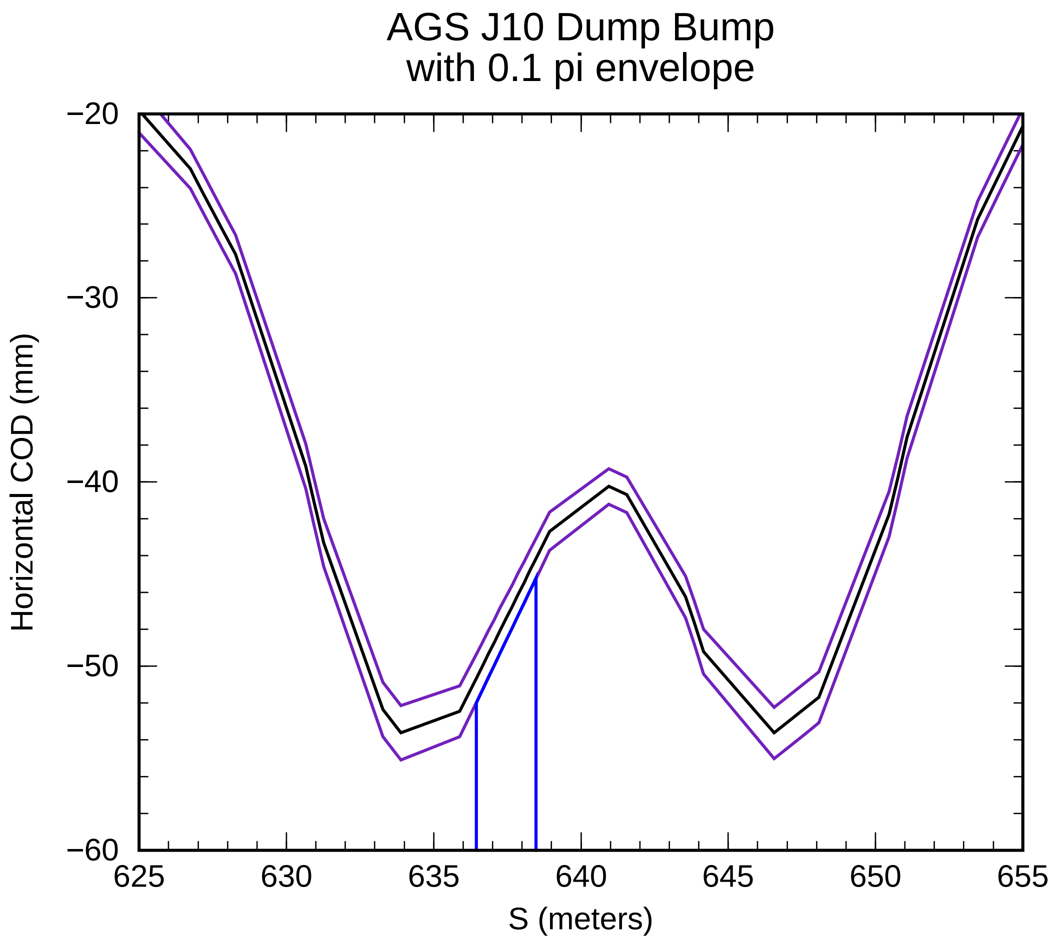

Figure 5: Here the bump amplitude has been inreased further still, causing beam loss on the dump and reducing the beam emittance to 0.1π.

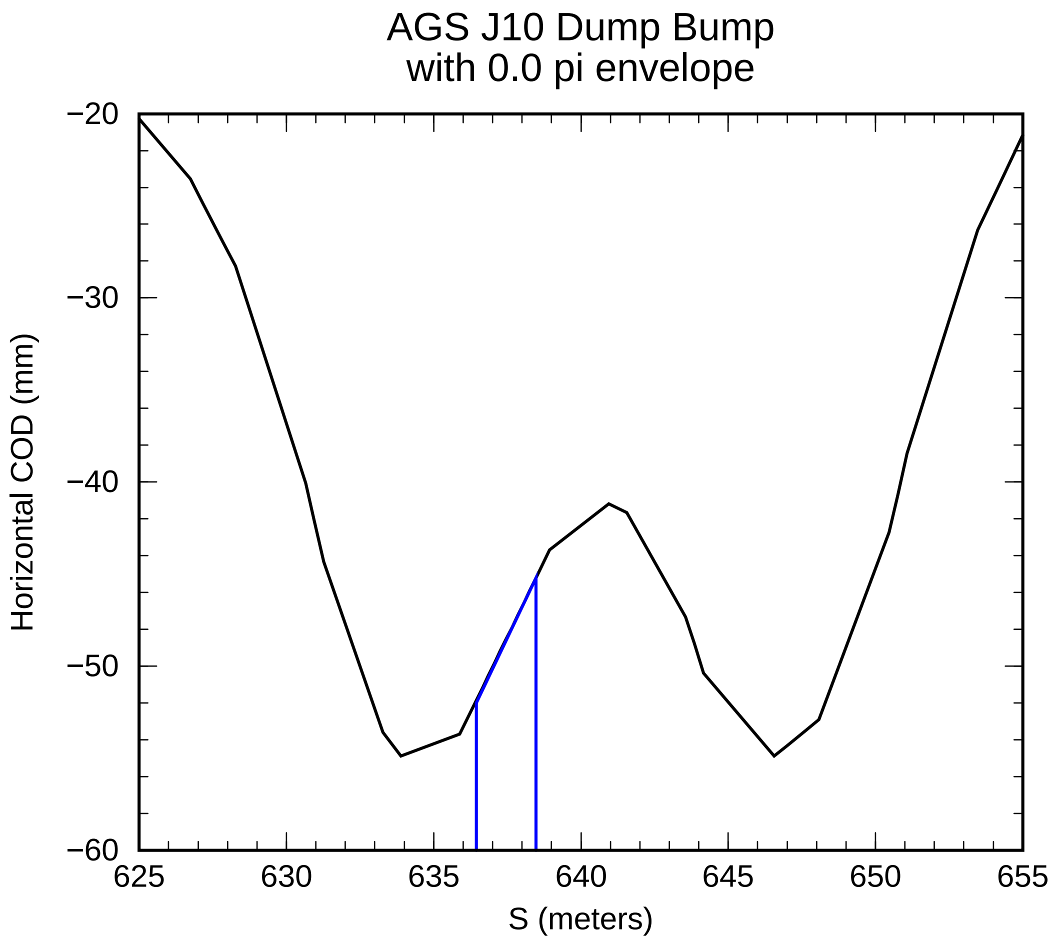

Figure 6: Here the bump amplitude has been inreased further, causing beam loss on the dump and reducing the beam emittance to 0.0π.

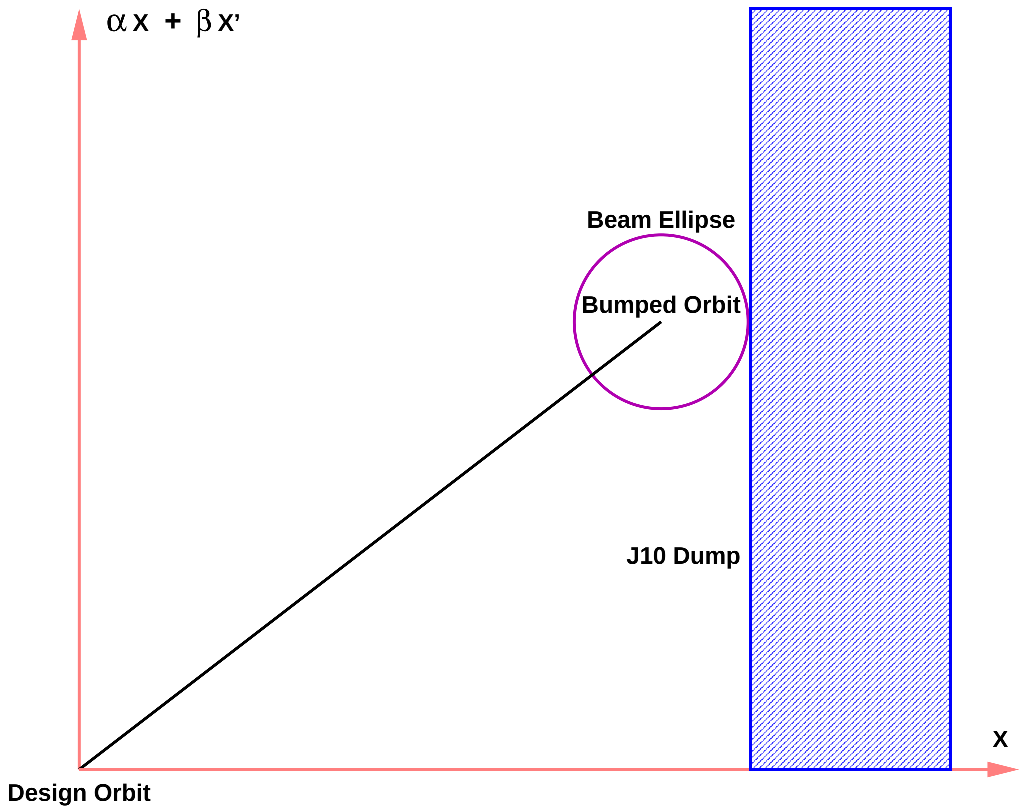

Figure 7: Here, and in the following figures, is the process of the previous figures illustrated in normalized phase space.

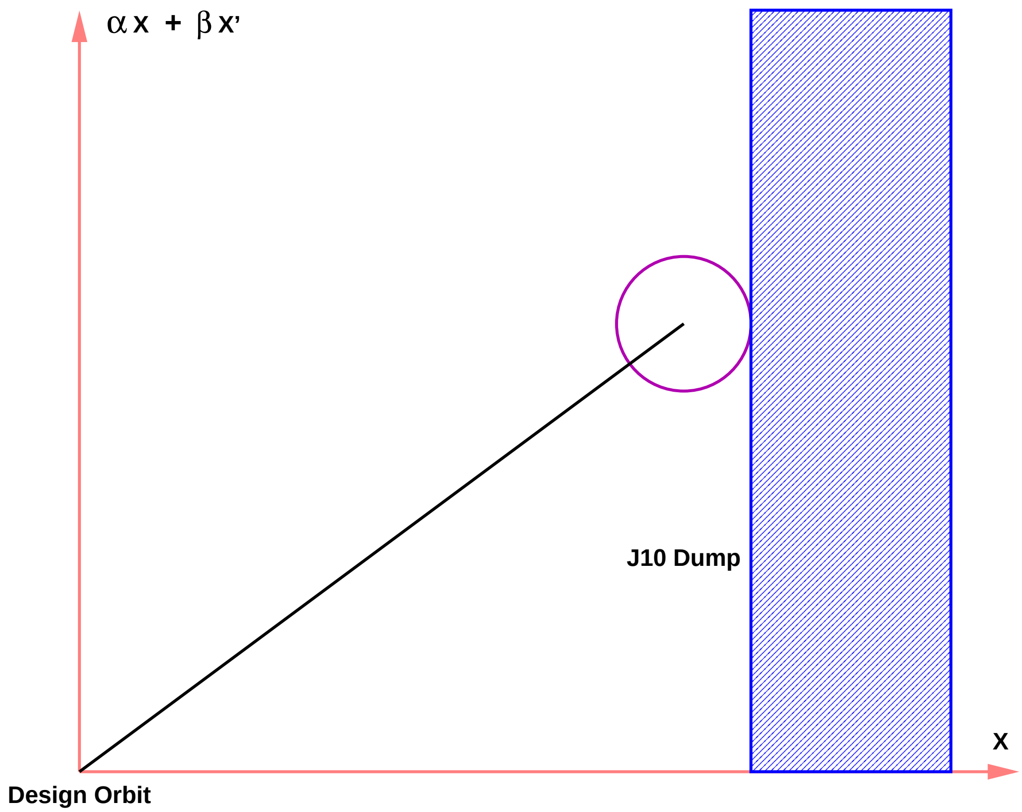

Figure 8: Here the bump amplitude has been inreased causing beam loss on the dump and reducing the beam emittance.

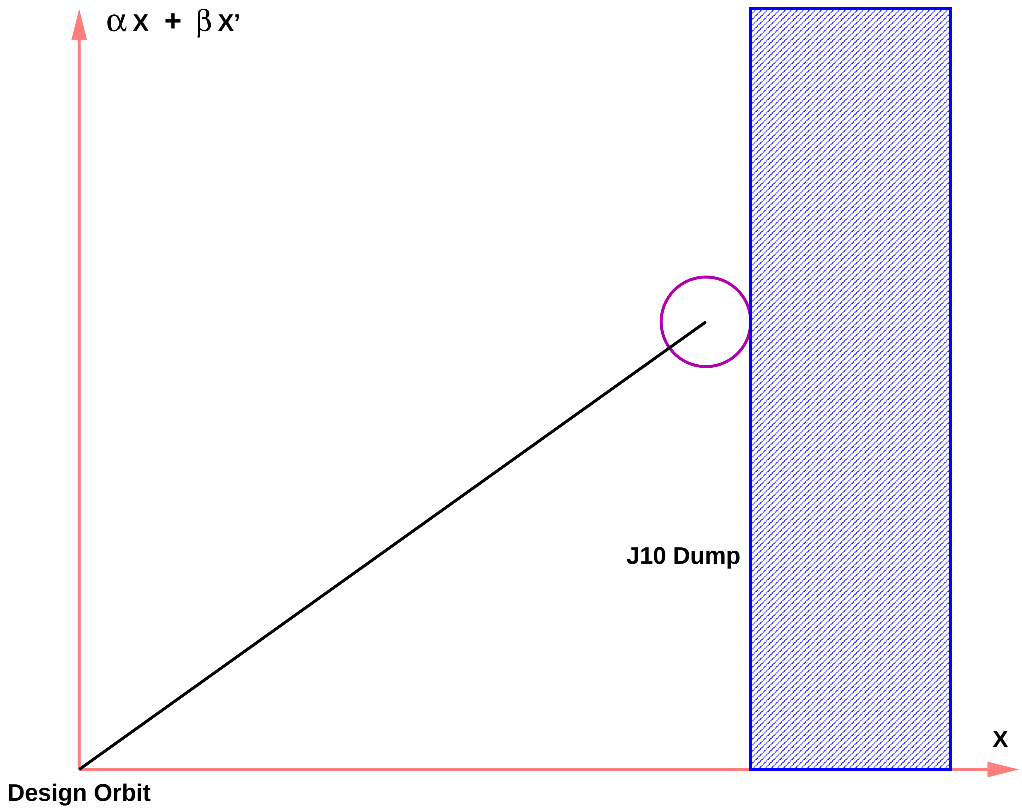

Figure 9: Here the bump amplitude has been inreased further, again causing beam loss on the dump and reducing the beam emittance.

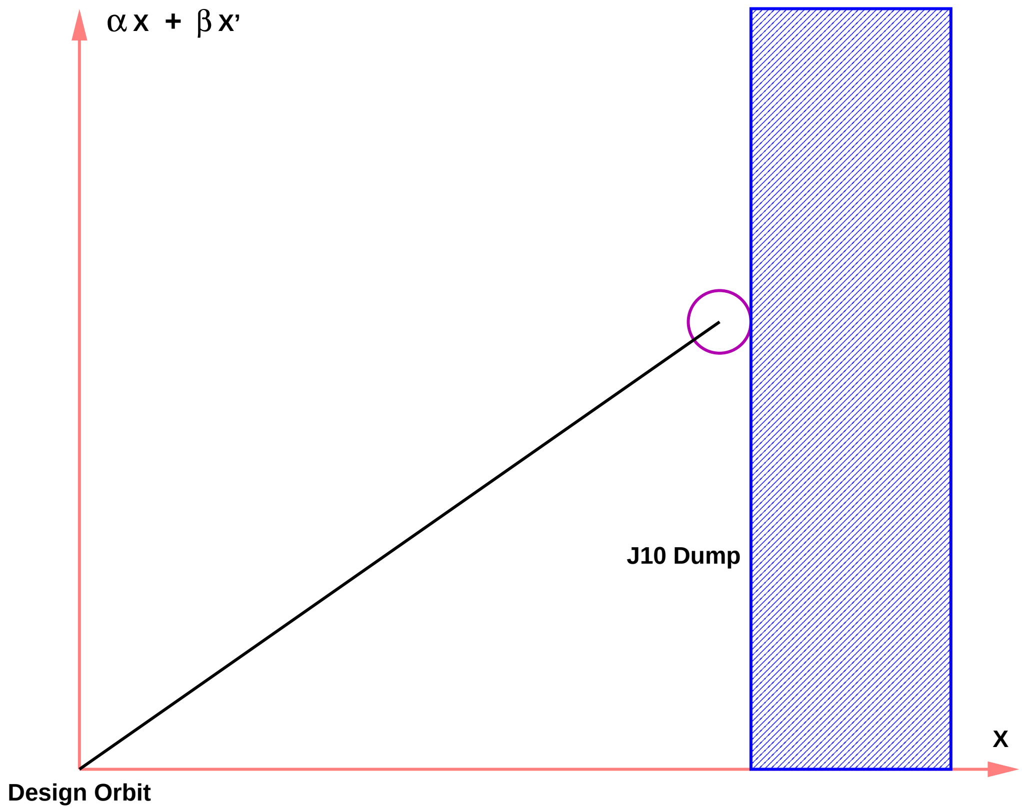

Figure 10: Here the bump amplitude has been inreased further still, causing beam loss on the dump and reducing the beam emittance.

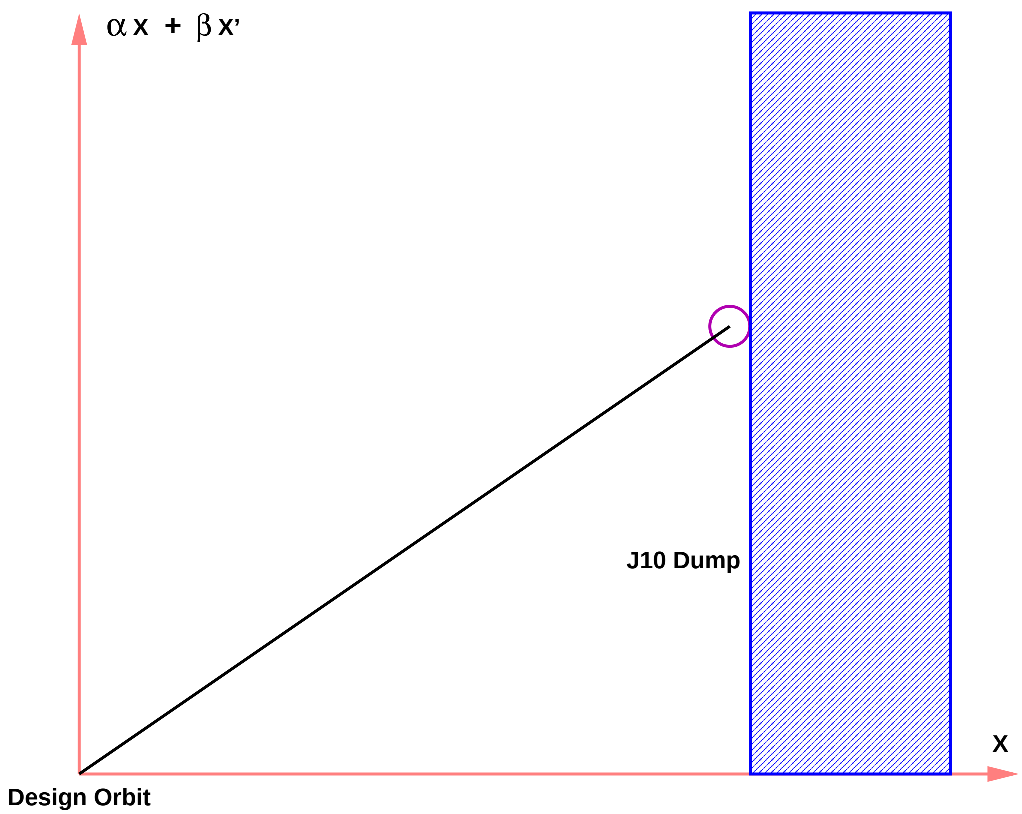

Figure 11: Here the bump amplitude has been inreased further, causing beam loss on the dump and reducing the beam emittance.

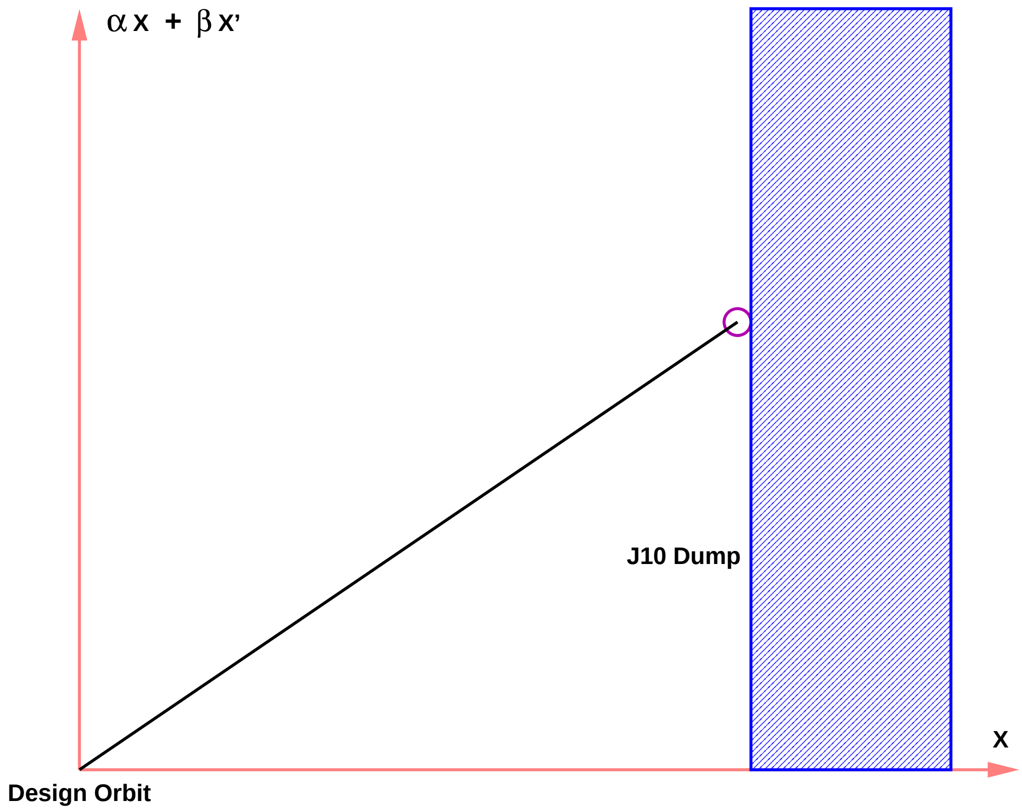

Figure 12: Here the bump amplitude has been inreased further, causing beam loss on the dump and reducing the beam emittance.

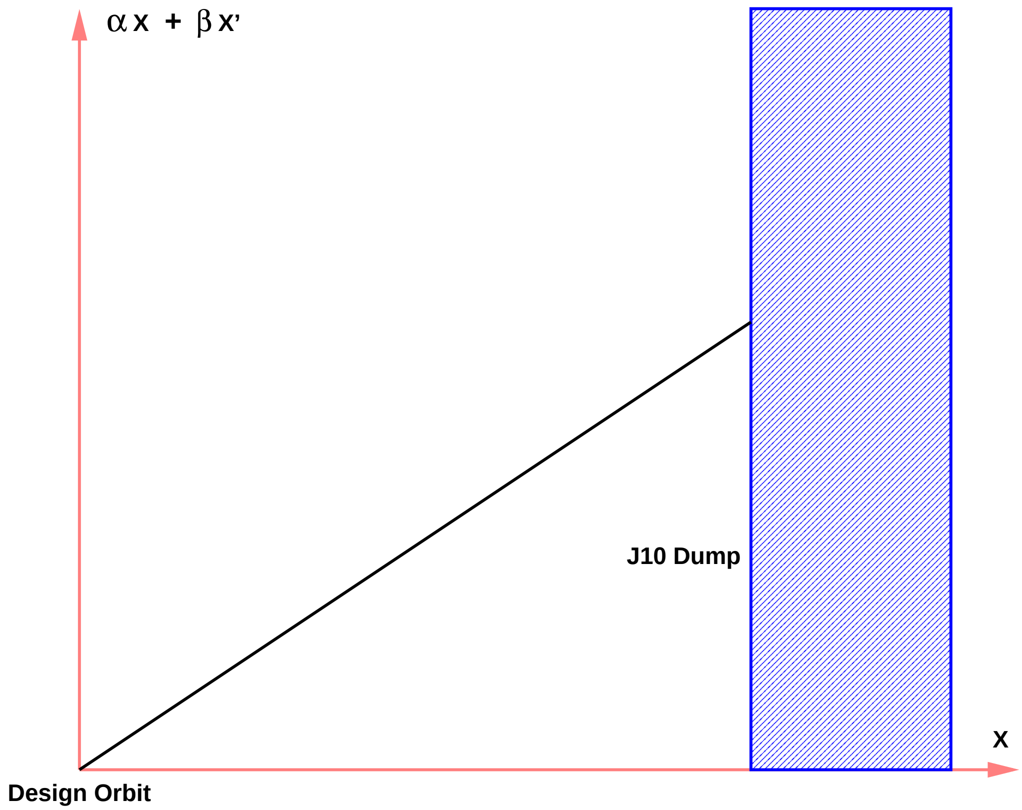

Figure 13: Here the bump amplitude has been inreased further, causing beam loss on the dump and reducing the beam emittance.

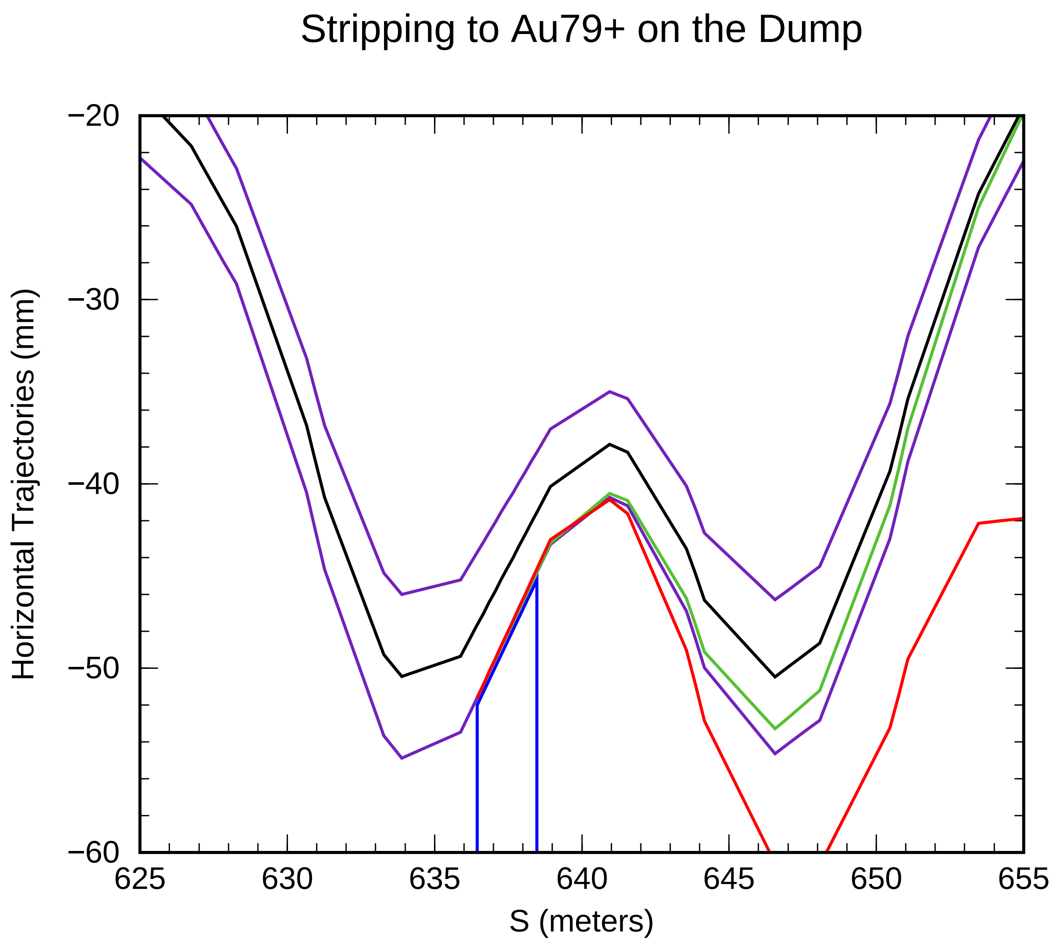

Figure 14: Here the red curve shows the trajectory of a gold ion that has been stripped to Au79+ by just grazing the surface of the dump. The green curve is the trajectory of an unstripped Au77+ ion with the same initial coordinates. As before, the black curve is the dump bump, the violet curves show the envelope of the 0.9 π emittance beam and the blue lines show the outline of the dump.

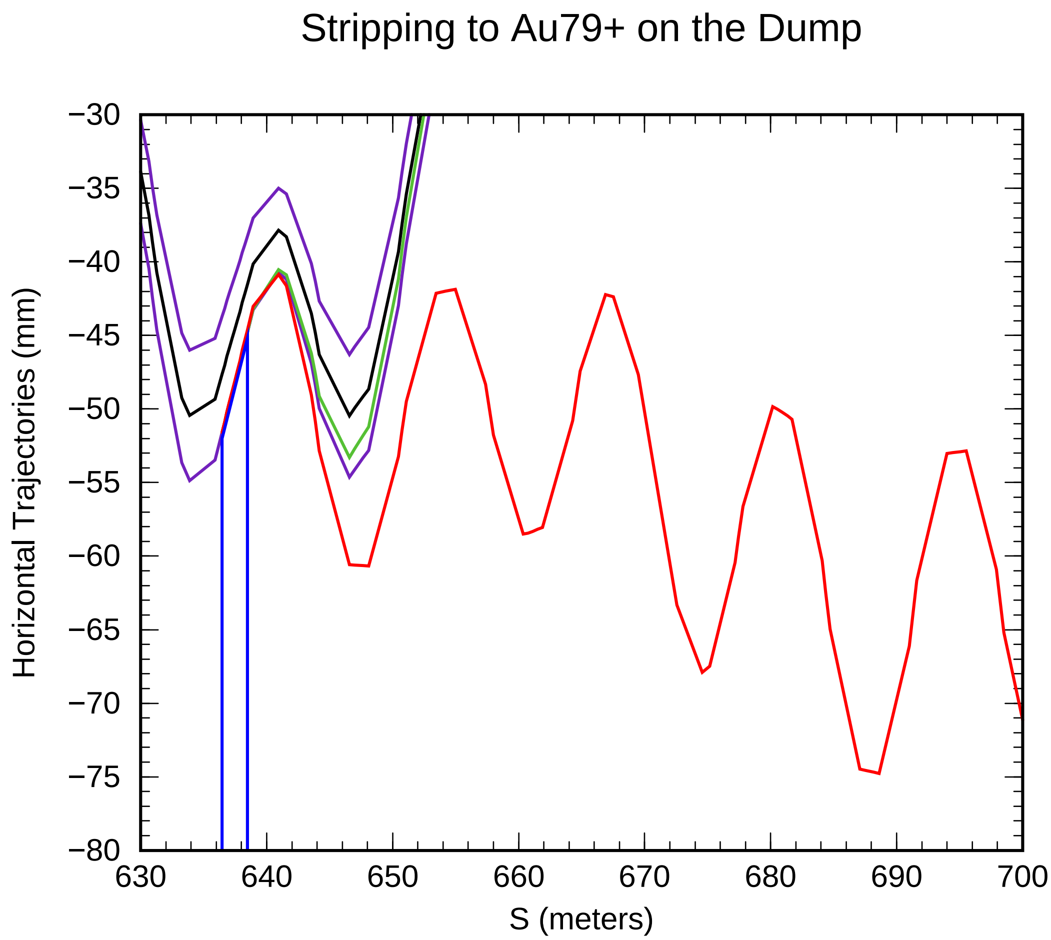

Figure 15: This a “zoomed out” view of the previous figure showing the trajectory of the stripped Au79+ ion. Going from left to right, the local minima of the trajectory are located at J13, J17, K1, and K5 respectively. During Run 8 beam loss was observed at J17 when gold beam was put into the dump.

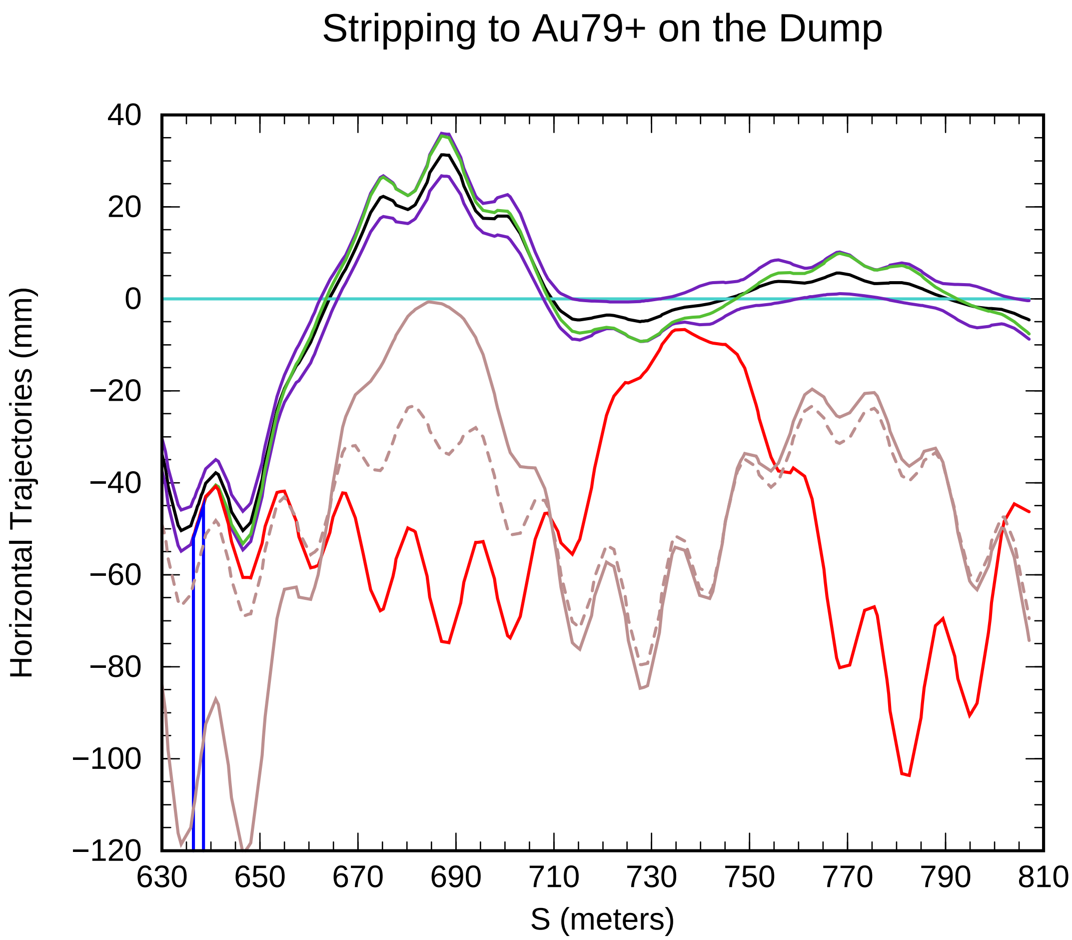

Figure 16: Here we have "zoomed out" further. The solid brown curve is the equilibrium orbit about which the Au79+ ion is oscillating. The dashed curve is the periodic dispersion multiplied by $\Delta p/p = -2/77$.

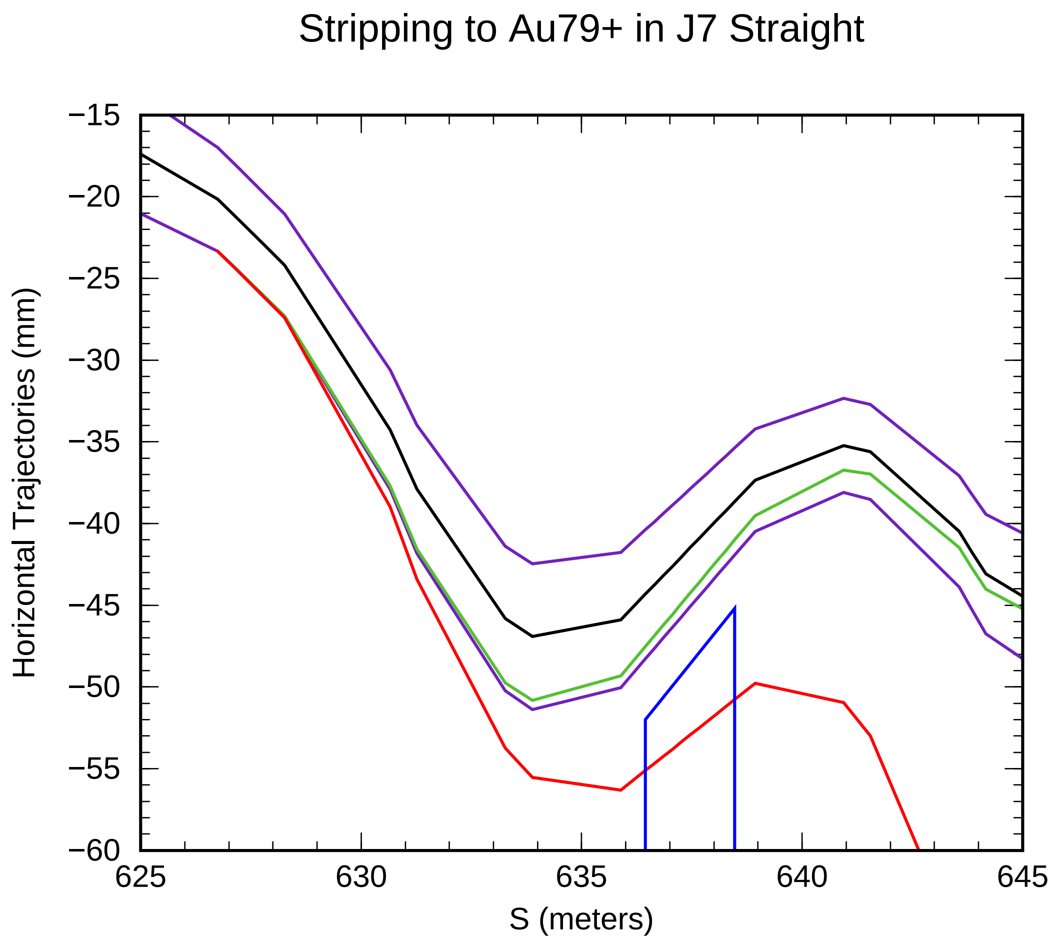

Figure 17: Here the red curve shows the trajectory of a gold ion that has been stripped to Au79+ by passing through a stripper located in the J7 straight. The green curve is the trajectory of an unstripped Au77+ ion with the same initial coordinates. The stripped ion is cleanly lost on the upstream face of the dump.

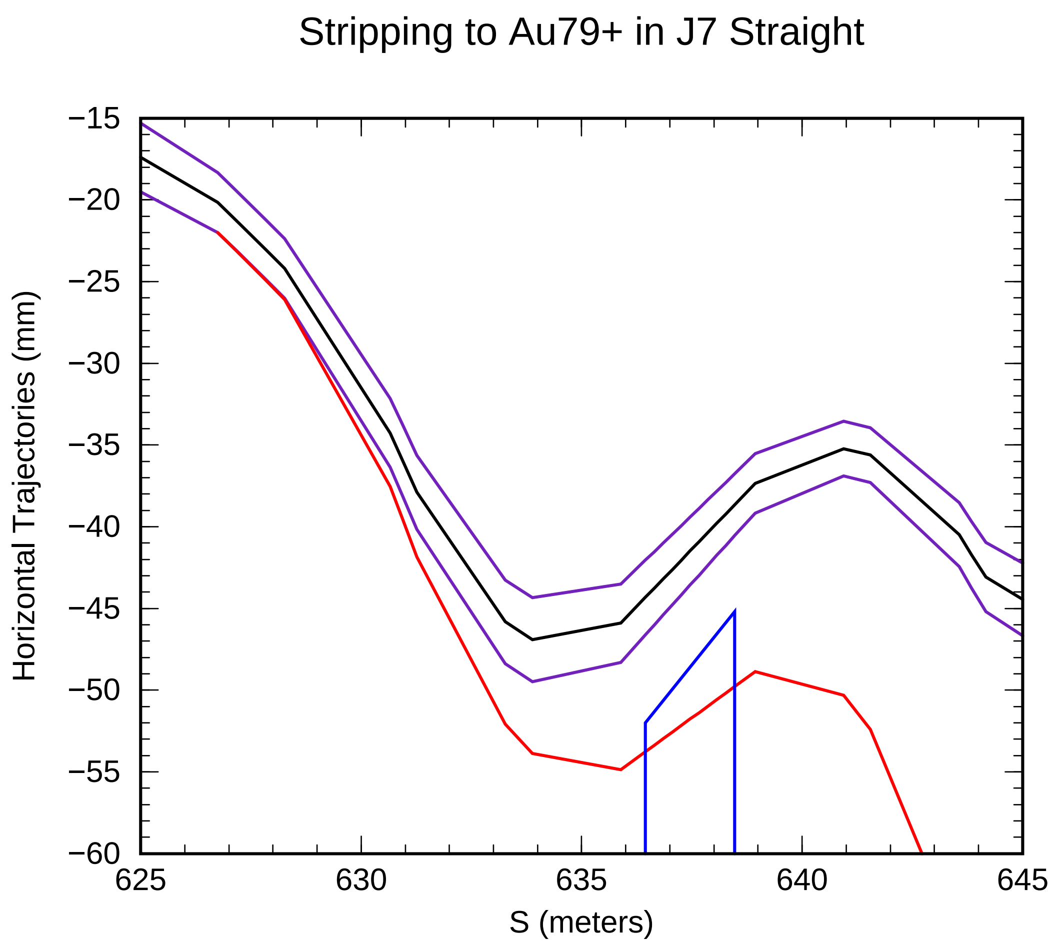

Figure 18: Holding the dump bump fixed we plung the J7 stripper further into the beam thereby reducing the circulating beam emittance while putting the stripped beam cleanly into the upstream face of the dump.

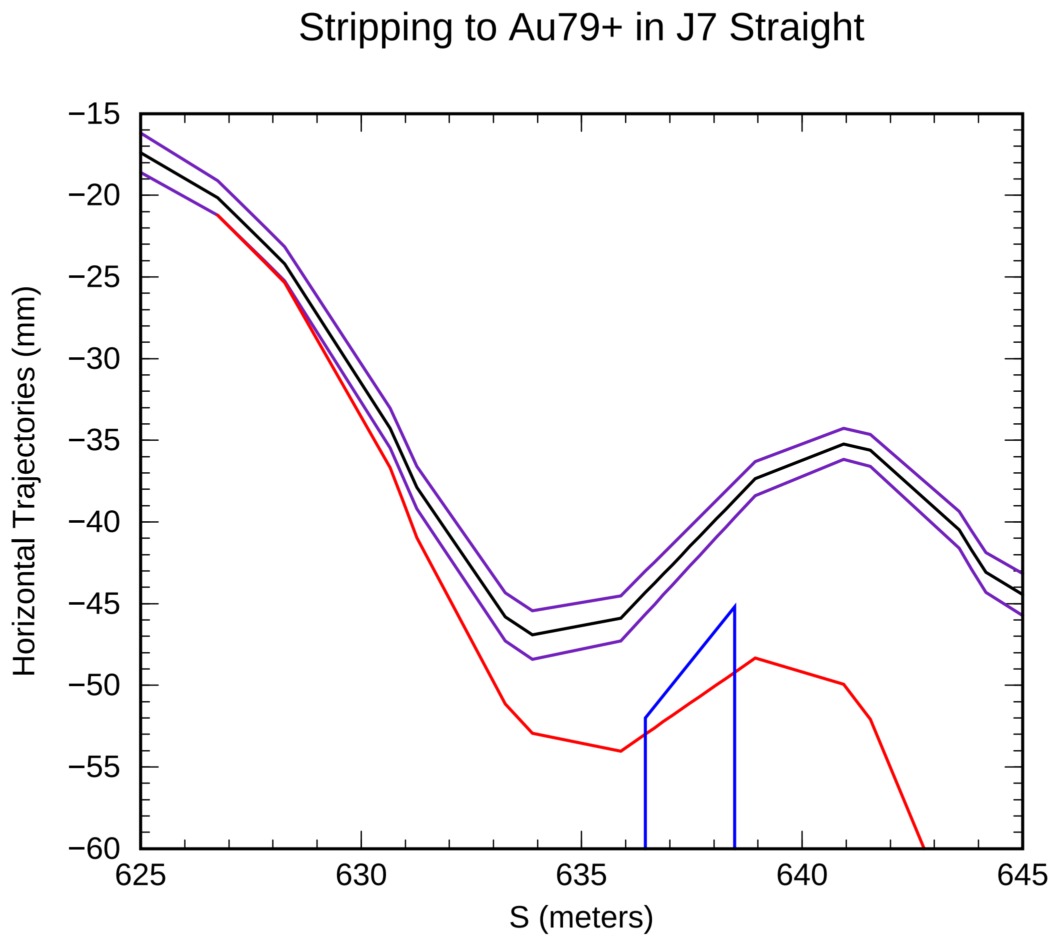

Figure 19: Holding the dump bump fixed we plung the J7 stripper further into the beam thereby reducing the circulating beam emittance while putting the stripped beam cleanly into the upstream face of the dump.

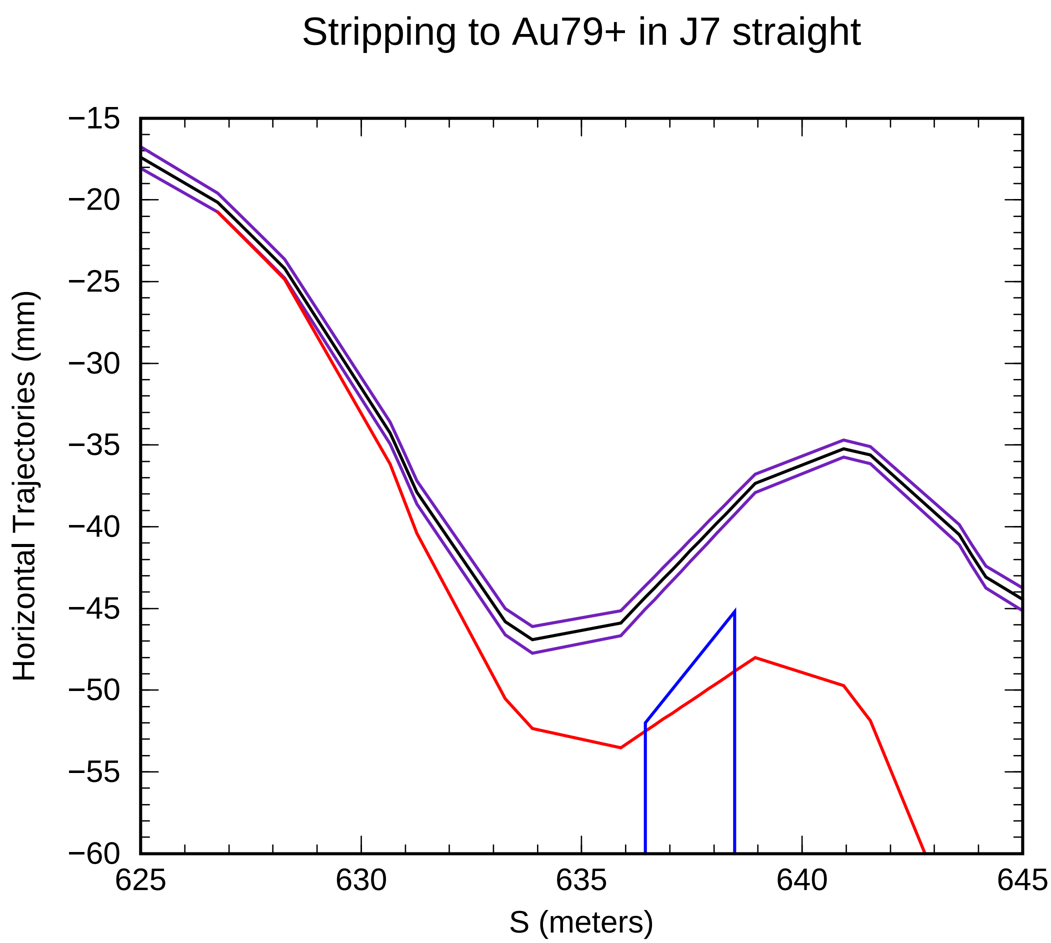

Figure 20: Holding the dump bump fixed we plung the J7 stripper further into the beam thereby reducing the circulating beam emittance while putting the stripped beam cleanly into the upstream face of the dump.

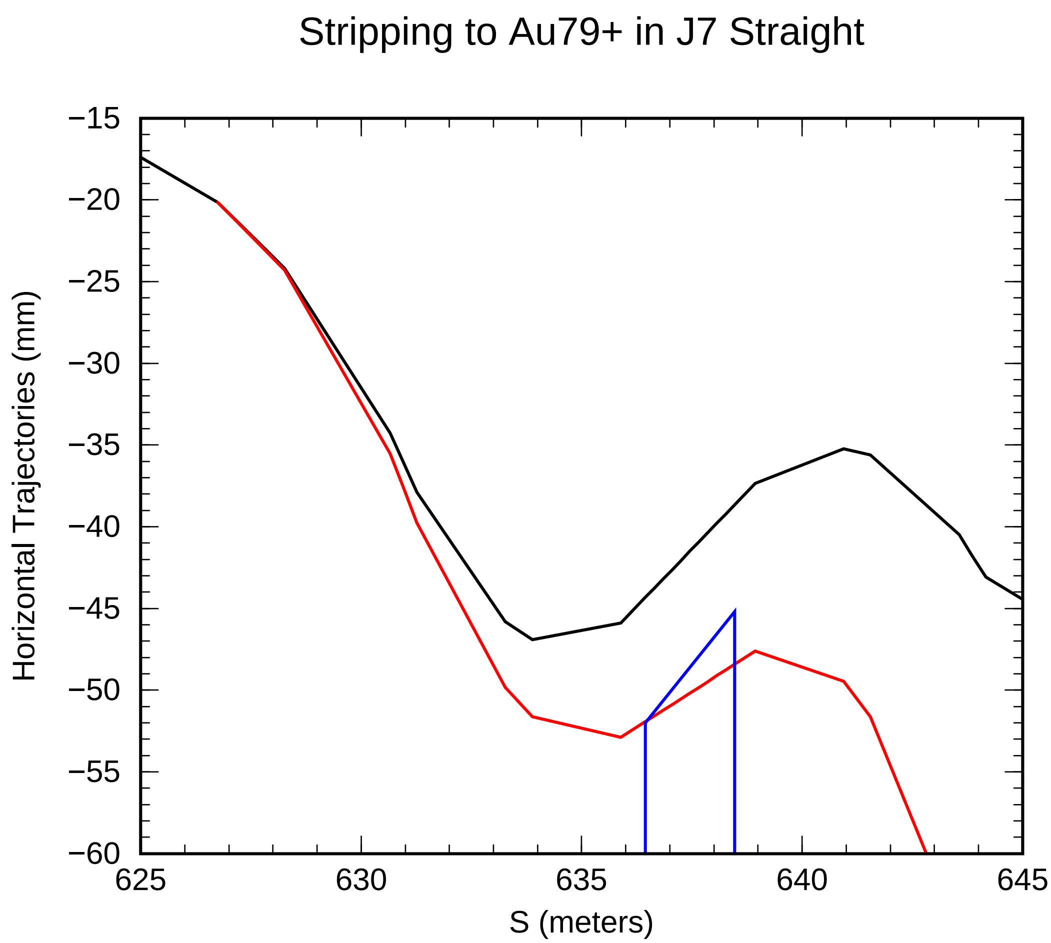

Figure 21: Holding the dump bump fixed we plung the J7 stripper further into the beam thereby reducing the circulating beam emittance while putting the stripped beam cleanly into the upstream face of the dump.

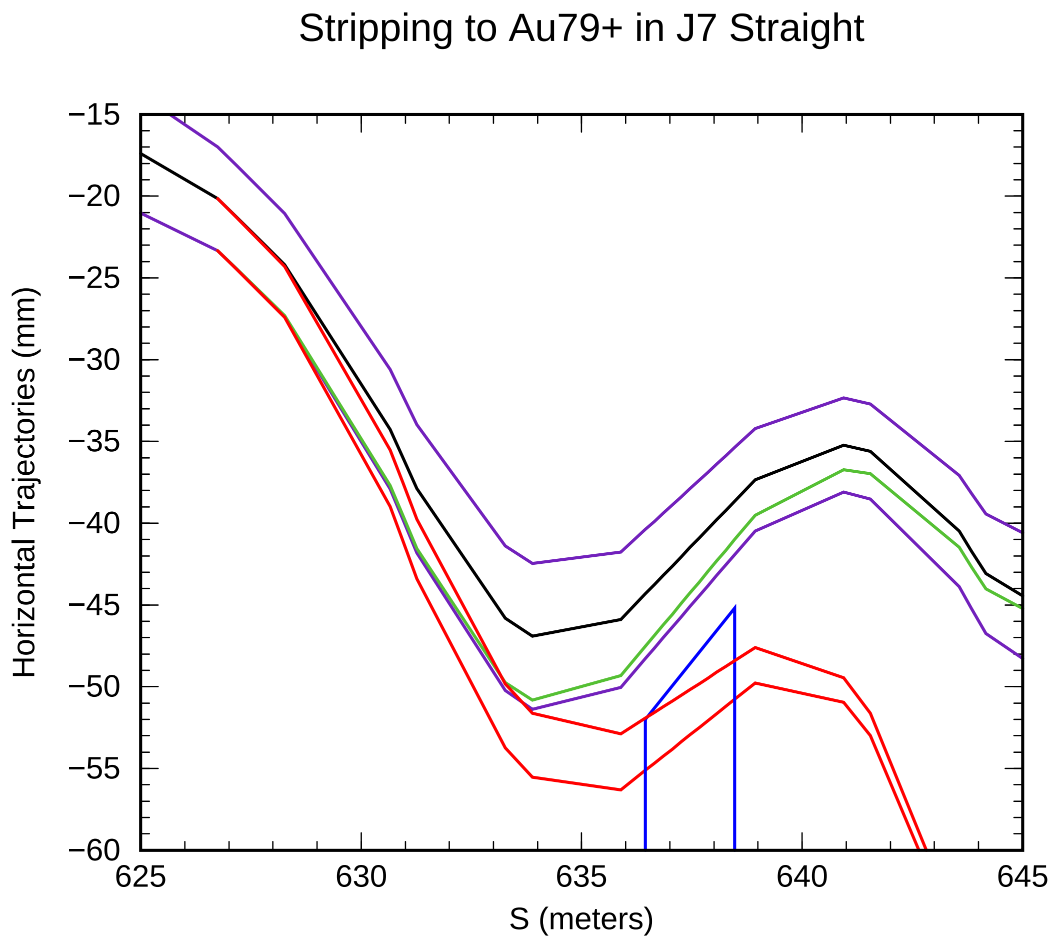

Figure 22: Here are the initial and final Au79+ ion trajectories obtained as the J7 stripper is plunged into the circulating beam. Note that the ions are lost at different locations on the face of the dump as the stripper moves into the beam. Note also that the magnet vacuum chamber aperture is at −3.406 inches (−86.5 mm).

Figure 23: Here is a current picture of the J7 straight. Most of the straight is occupied by the J7 sextupole. The J7 skew sextupole sits at the upstream end (to the left of the sextupole).

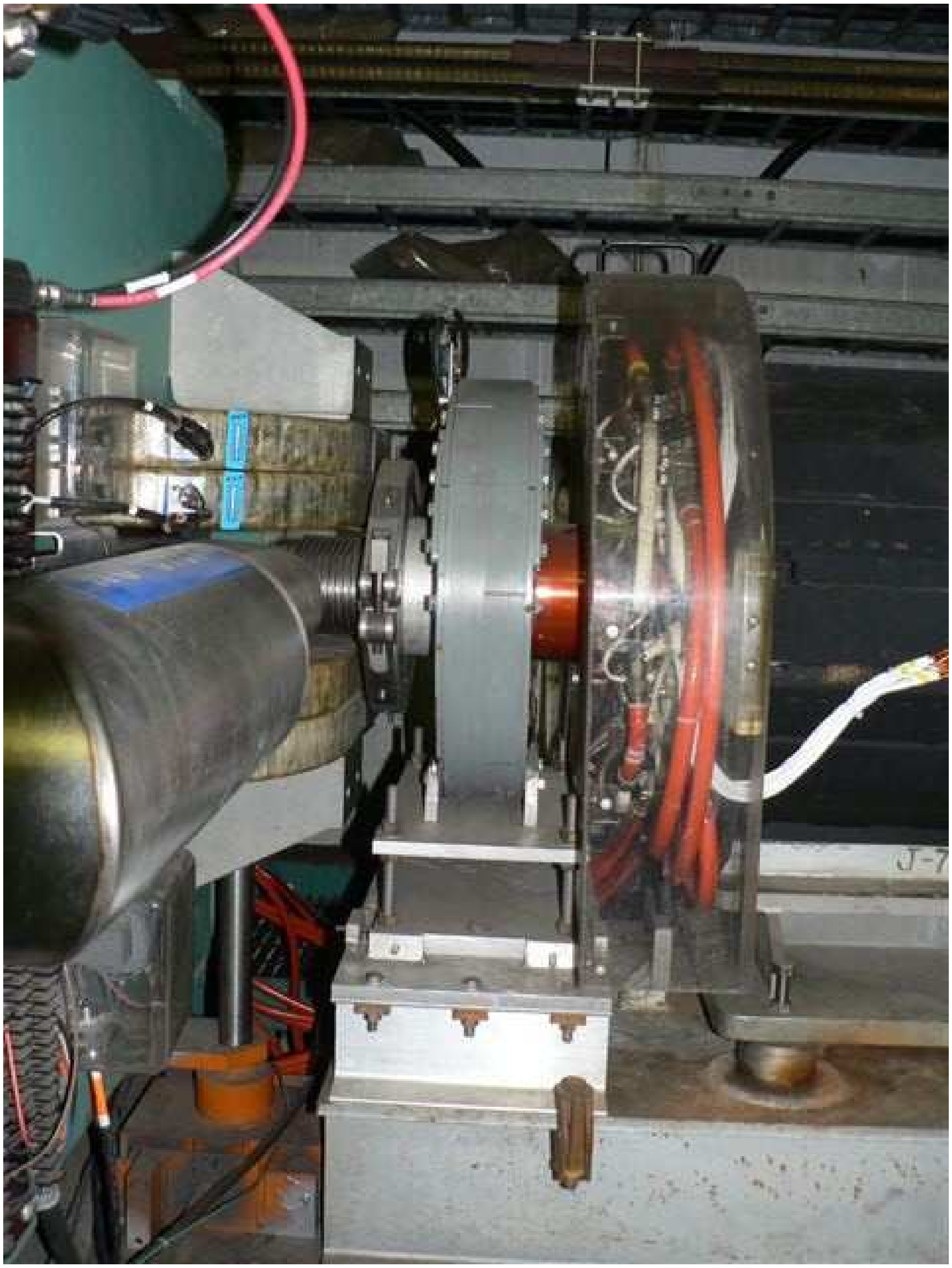

Figure 24: Here is a closer view of the skew sextupole at the upstream end of the J7 straight. This is what would have to be removed to make room for a stripper.

Figure 25: Here is a current picture of the F5 straight with the horizontal and vertical jump target mechanisms at the upstream (to the left) and downstream ends respectively.

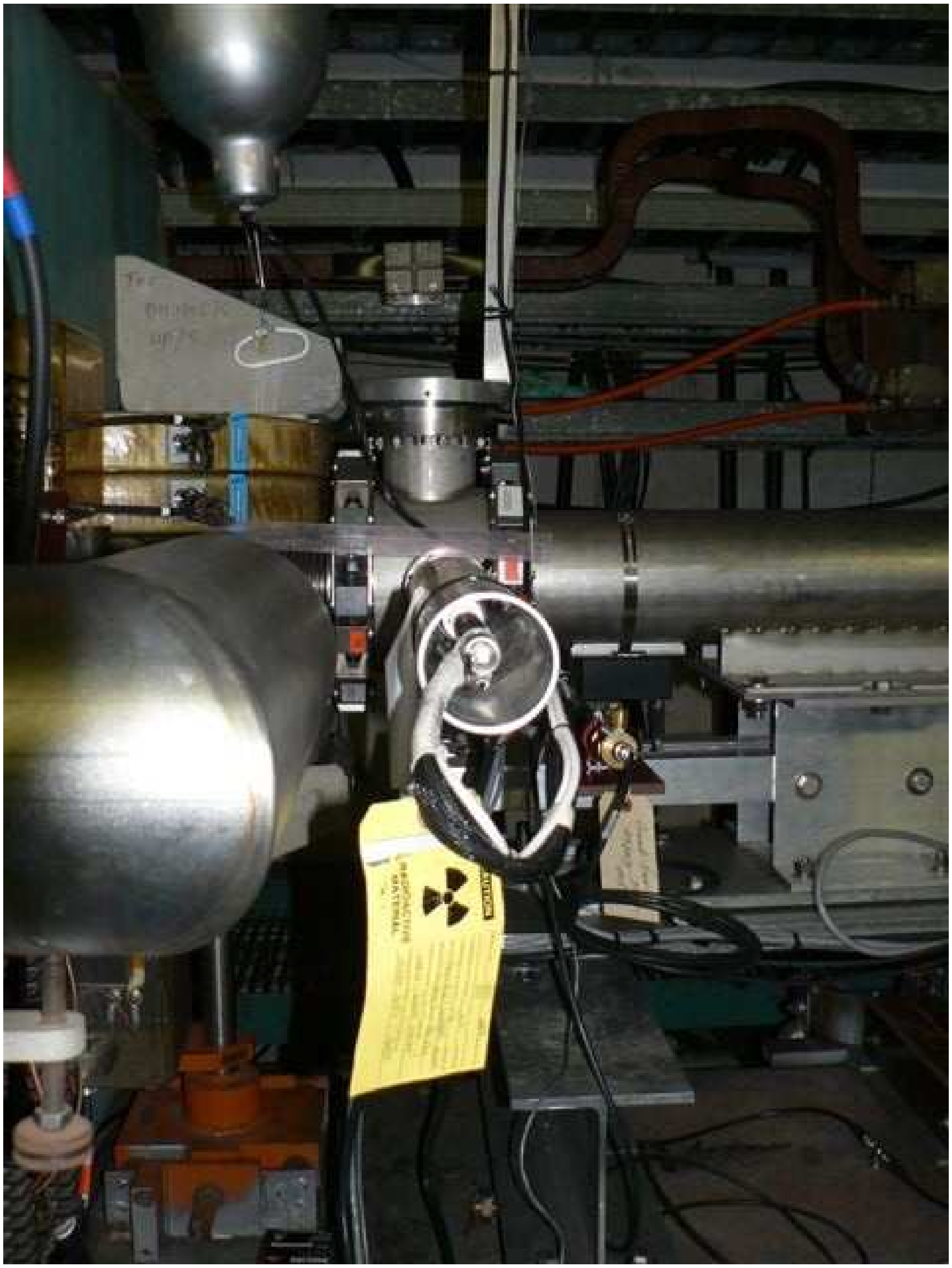

Figure 26: Here is a closer view of the horizontal jump target mechanism at the upstream end of the F5 straight. Our proposal is to move this mechanism to the J7 straight and use it to insert a stripper into the beam.

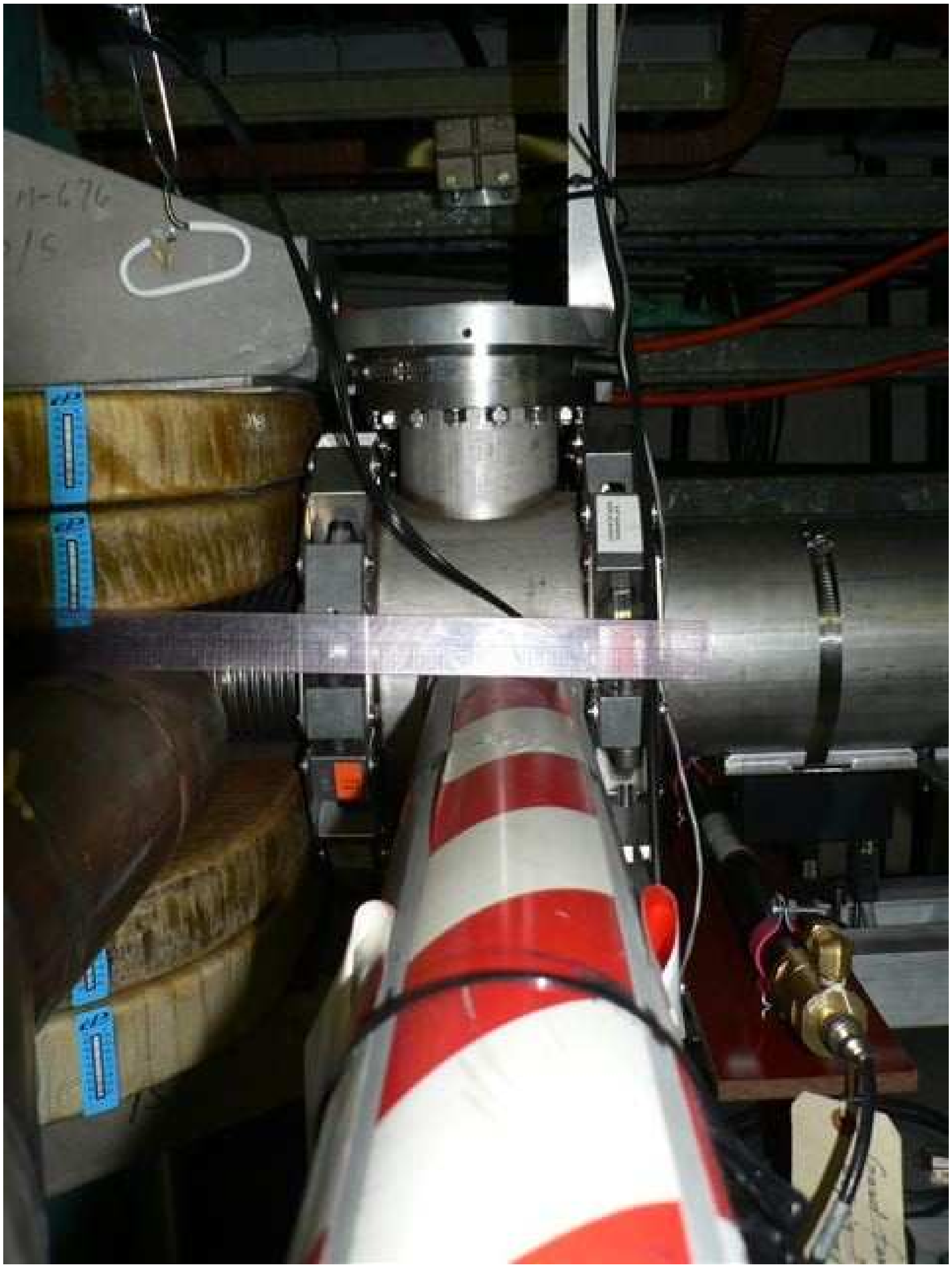

Figure 27: Here is an even closer view.

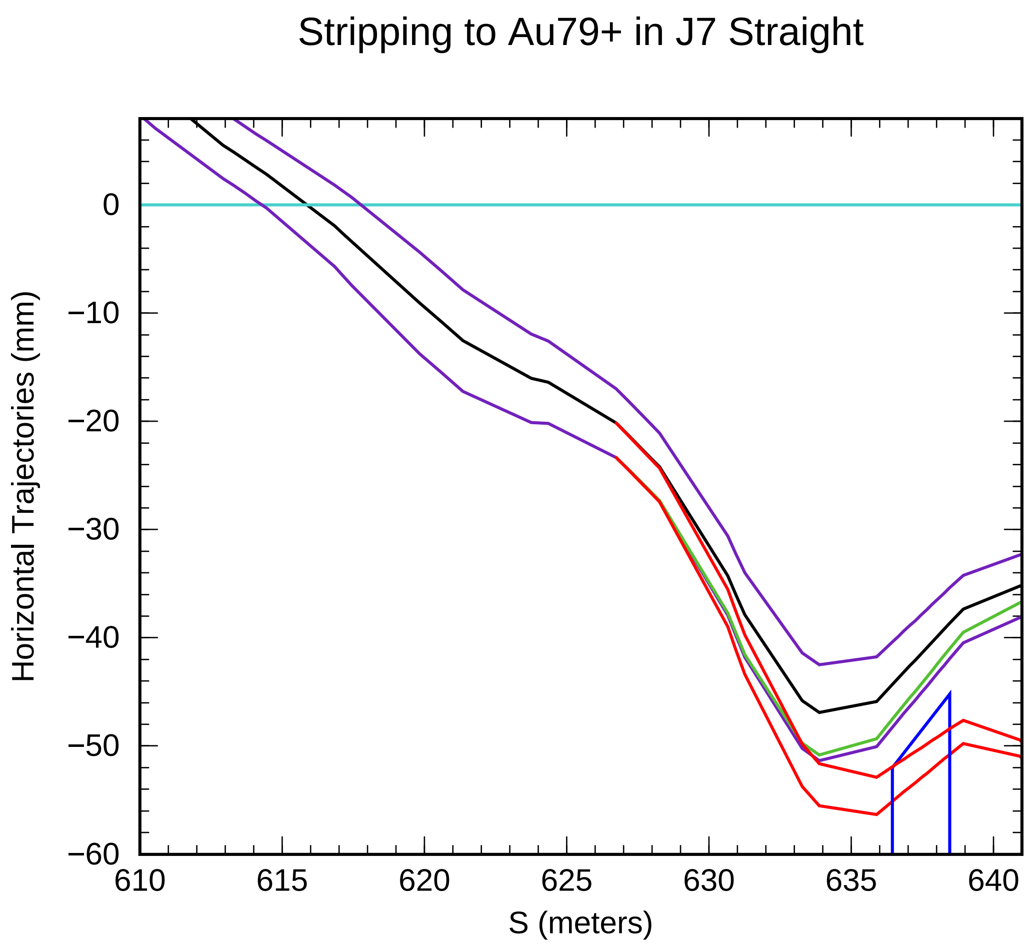

Figure 28: Here is a "zoomed out" view of the initial and final trajectories obtained as the J7 stripper is plunged into the circulating beam.

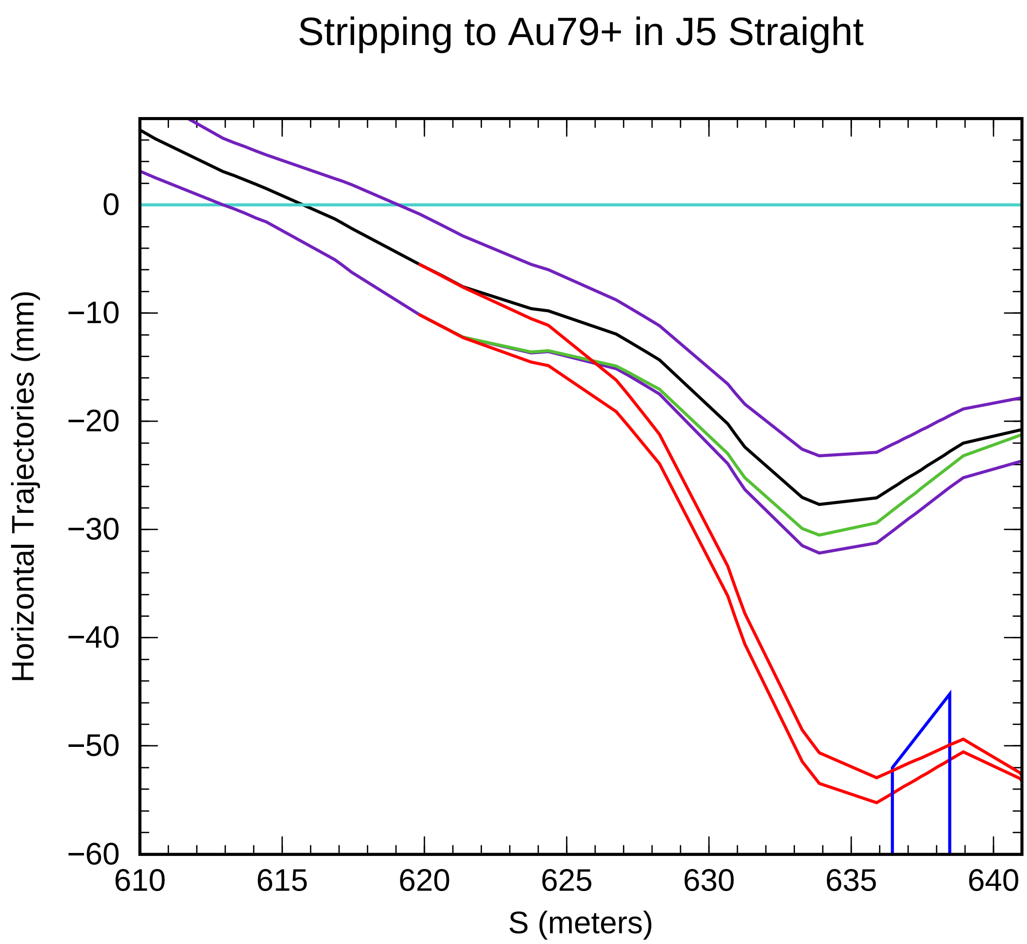

Figure 29: Here are the initial and final Au79+ trajectories obtained for the case in which a stripper is plunged into the circulating beam in the J5 straight.

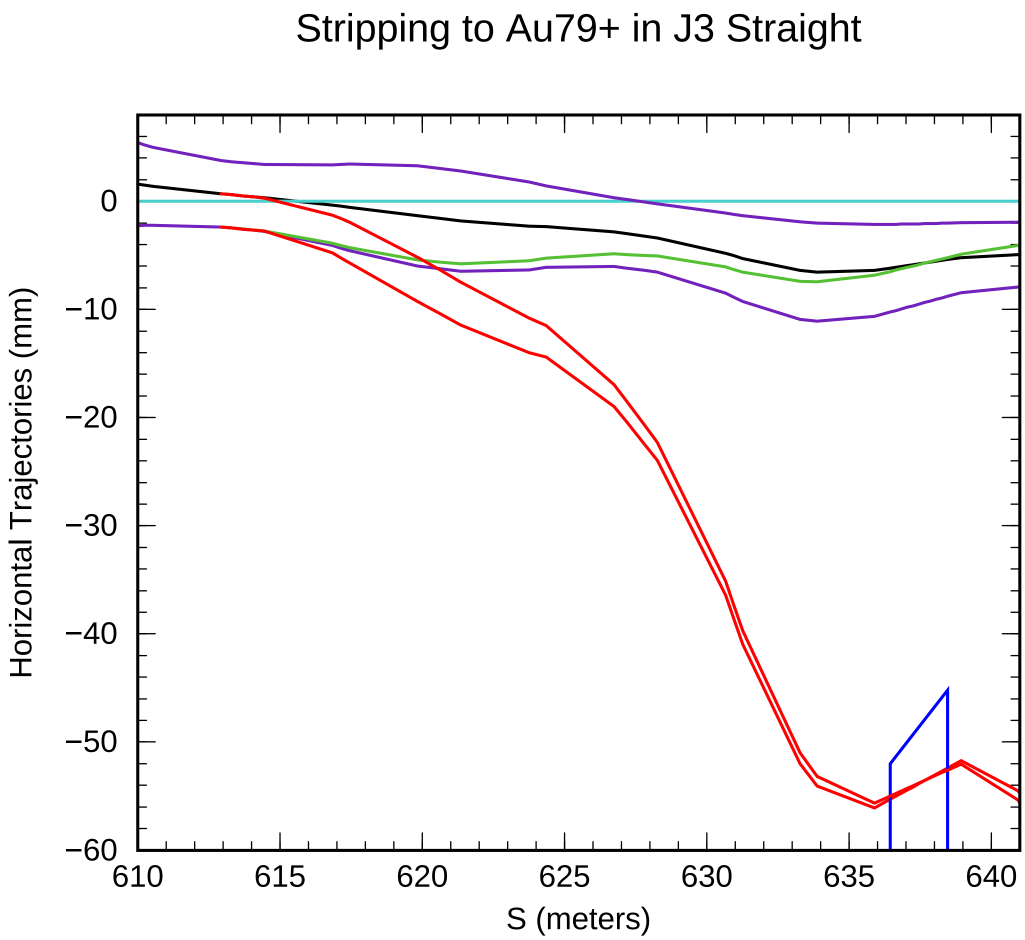

Figure 30: Here are the initial and final Au79+ trajectories obtained for the case in which a stripper is plunged into the circulating beam in the J3 straight. Note that because the phase advance between J3 and J10 is close to $\pi/2$, the trajectories converge to a point on the upstream face of the dump.

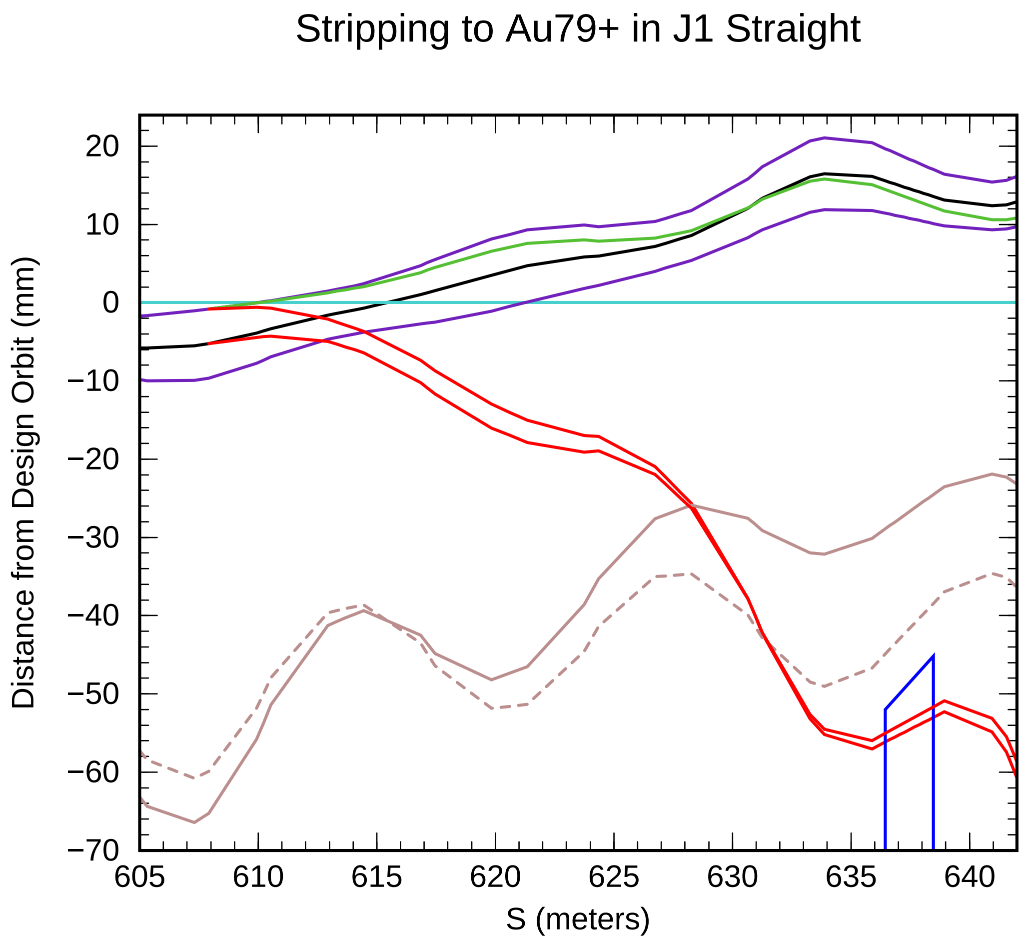

Figure 31: Here are the initial and final Au79+ trajectories obtained for the case in which a stripper is plunged into the circulating beam (now from the outside) in the J1 straight. Note that because the phase advance between J1 and J10 is still close to $\pi/2$, the trajectories are close to one another on the upstream face of the dump.

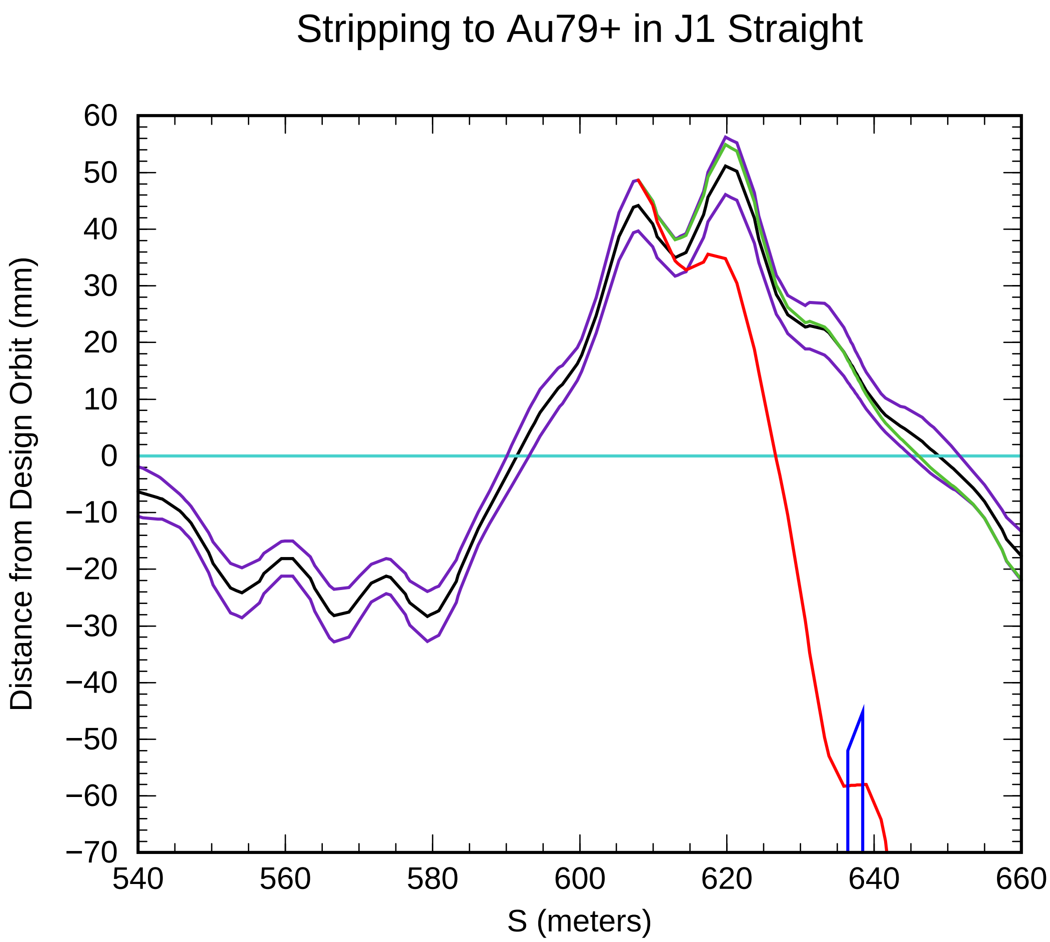

Figure 32: Here is the Au79+ trajectory obtained for the case in which a stripper is located in the J1 straight. In this case the stripper is held fixed and the circulating beam is moved into it with a programable bump.

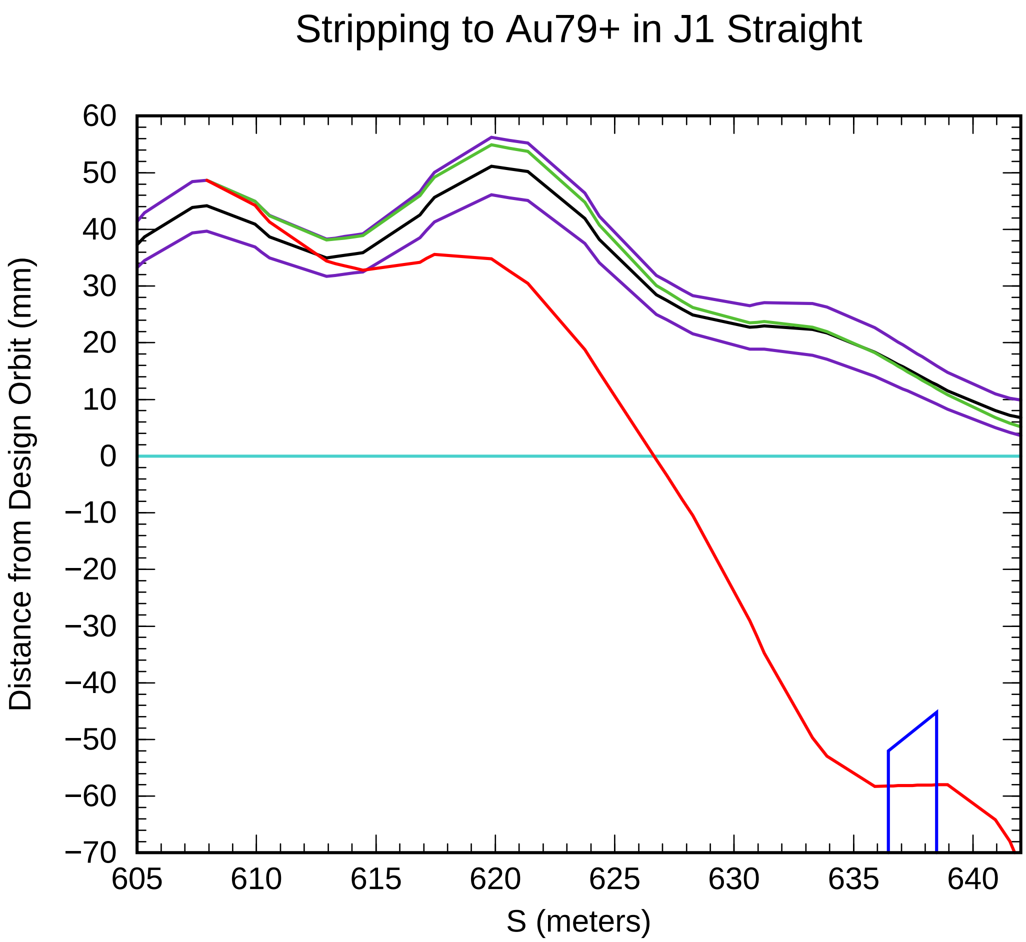

Figure 33: “Zoomed in” view of the previous figure.

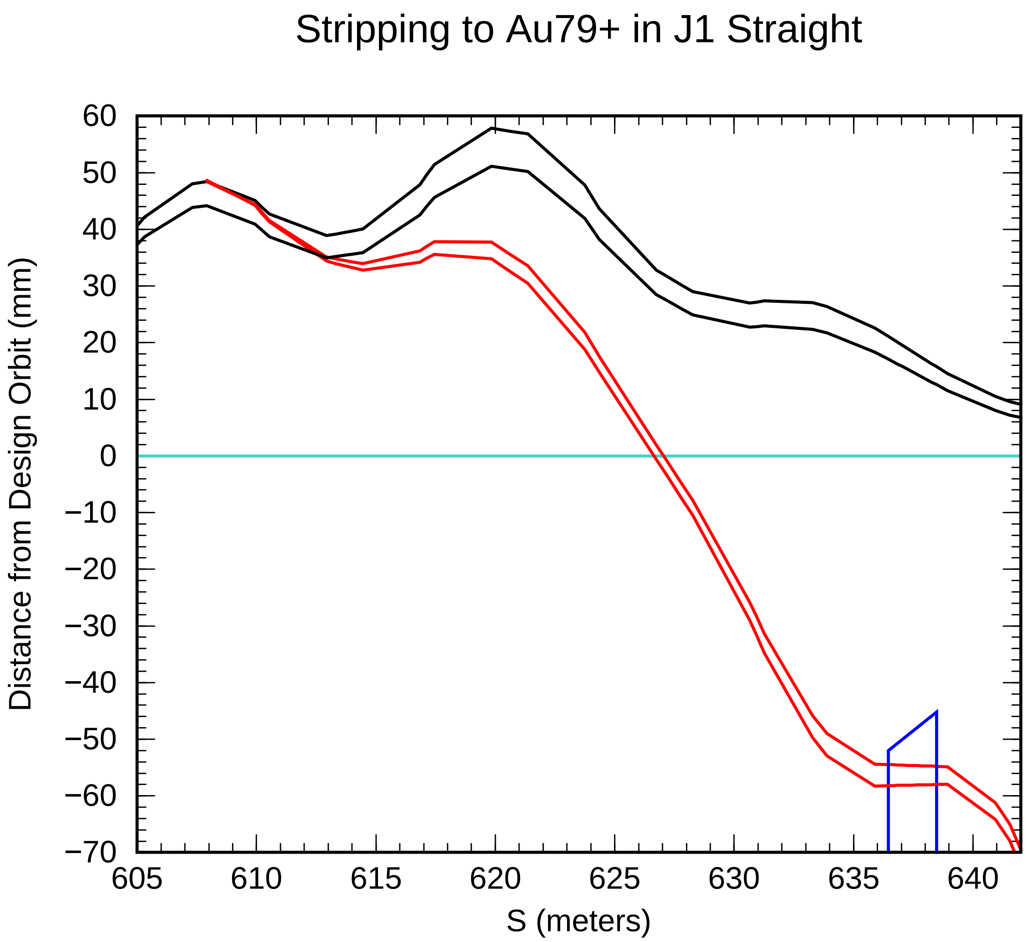

Figure 34: Closed orbit and Au79+ trajectory of the previous figure and the Au79+ trajectory obtained with the orbit moved just to the point where all circulating beam has been removed.

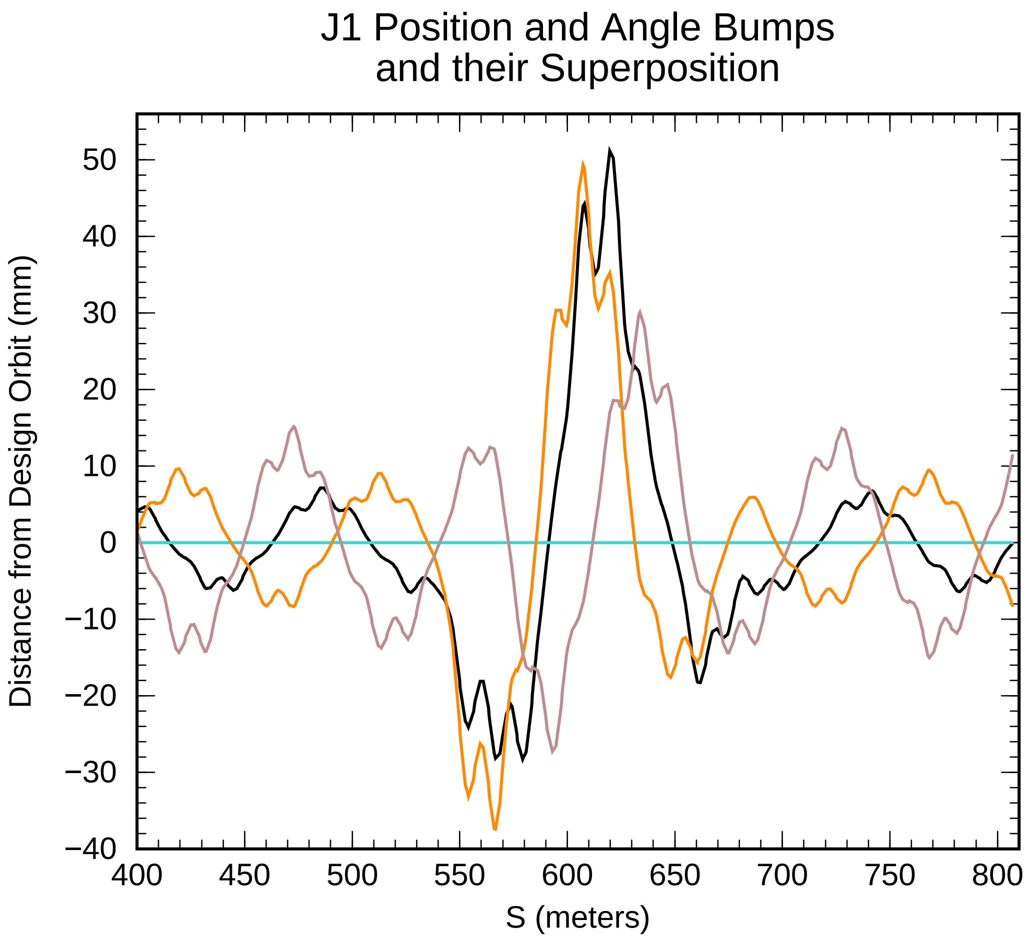

Figure 35: J1 Position and Angle Bumps (orange and brown curves) and their Superposition (black curve).